Occupational Cancer Mortality Among Women Employed in the Telephone Industry

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We conducted a mortality odds ratio (MOR) analysis among women employed in the telephone industry, using death certificates from 24 reporting states for 1984 through 1989. Usual occupation and industry from the death certificates were coded using the 1980 Bureau of the Census occupational and industrial classification system. There were 2444 cancer deaths among women in the telephone industry (code 441). Among younger (age <49) white women, significant excess risks were observed from cancers of the rectum (MOR = 3.3; 95% confidence interval [CI] = 1.2 to 8.7), connective tissue (MOR = 4.4; 95% CI = 2.2 to 8.8), breast (MOR = 1.6; 95% CI = 1.3 to 2.1), corpus uteri (MOR = 3.3; 95% CI = 1.5 to 7.5), ovary (MOR = 2.1; 95% CI = 1.3 to 3.5), and brain (MOR = 2.1; 95% CI = 1.2 to 3.7). Cancer of the connective tissue showed an almost sixfold risk (MOR = 5.5; 95% CI = 2.0 to 14.8) for the age group of 30 to 39 years. Excess risks of cancer of the connective tissue were observed among engineers and technicians, office workers, telephone operators, and mechanics and repairers (MOR = 8.5, 4.9, 1.7, and 4.4, respectively), suggesting a possible relationship with modern technological exposures in the telephone industry. Risks for cancers of the breast, corpus uteri, ovary, and brain were also elevated among these jobs. We did not have information on other risk factors for these cancer sites; therefore, socioeconomic status or lifestyle may explain these observed associations, particularly for the cancers of the reproductive system. Possible exposure to new instruments, machinery, or production procedures introduced in the modern telephone industry also may account for excess risks observed, particularly among younger women.

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One of the economic sectors in which women employees are in the majority (52%) is the telephone industry.[1] This proportion is particularly high (97%) among telephone operators.[1] An inquiry by a citizen regarding soft-tissue sarcoma among telephone operators stimulated a review of studies in the telephone industry. Although various studies have been carried out among employees in the telephone industry,[2-23] few studies have focused on cancers among female workers.[15,19,20]

To investigate cancer mortality patterns among women employed in the telephone industry, we used death certificates from 24-state occupational mortality data for the years 1984 through 1989.

Materials and Methods

Since 1984, the National Cancer Institute, the National Institute for Occupational Safety and Health, and the National Center for Health Statistics have supported the coding of industry and occupational titles on death certificates in 24 states (Colorado, Georgia, Idaho, Indiana, Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Washington, West Virginia, and Wisconsin).[1] The Bureau of the Census Index of Industries and Occupations was the coding scheme used.[24] We evaluated cancer risks for the telephone industry (code 441) as a whole and by occupational categories within the industry for various age groups. There were 2343 cancer deaths among white women and 101 among black women between

1984 and 1989 in the telephone industry.

Mortality odds ratios (MORs)[25] were calculated by race (black or white), age groups (20 to 49, 50 to 69, 70 and older, and all ages combined), geographical regions (West: Colorado, Idaho, Nevada, New Mexico, Utah, and Washington; Central: Indiana, Kansas, Missouri, Nebraska, Ohio, Oklahoma, and Wisconsin; South: Georgia, Kentucky, North Carolina, South Carolina, Tennessee, and West Virginia; and Northeast: Maine, New Hampshire, New Jersey, Rhode Island, and Vermont), and job titles in the industry, using a mortality analysis program developed by the National Cancer Institute.[26] In calculating expected values, all causes of deaths except cancers were used as auxiliary causes from the 24-state data base by year and by age at event.

Results

Table 1 presents results of MOR analyses by various age groups for white women. Mortality from all cancers was significantly elevated in all age groups. For all age groups combined, significantly excess risks were observed for non-Hodgkin's lymphoma (MOR = 1.2; 95% CI = 1.0 to 1.5) and cancers of the colon (MOR = 1.2; 95% CI = 1.1 to 1.4), rectum (MOR = 1.5; 95% CI = 1.1 to 2.0), connective tissue (MOR = 1.7; 95% CI = 1.1 to 2.6), breast (MOR = 1.4; 95% CI = 1.3 to 1.5), corpus uteri (MOR = 1.3; 95% CI = 1.1 to 1.7), and ovary (MOR = 1.4; 95% CI = 1.1 to 1.6). Among younger women (age group, 20 to 49 years), relatively higher and significant relative risks were observed for cancers of the rectum (MOR = 3.3; 95% CI = 1.2 to 8.7), connective tissue (MOR = 4.4; 95% CI = 2.2 to 8.8), breast (MOR = 1.6; 95% CI = 1.3 to 2.1), corpus uteri (MOR = 3.3; 95% CI = 1.5 to 7.5), ovary (MOR = 2.1; 95% CI = 1.3 to 3.5), and brain (MOR = 2.1; 95% CI = 1.2 to 3.7). The highest relative risk of non-Hodgkin's lymphoma was observed in the middle-age category (50 to 69 years; MOR = 1.7; 95% CI = 1.2 to 2.3).

Among black women (Table 2), for all ages combined, significant excess risks were observed for melanoma (MOR = 16.6; 95% CI = 5.4 to 51.1) and cancer of the breast (MOR = 2.2; 95% CI = 1.6 to 3.1).

Analyses by geographical regions for black and white women combined are presented in Table 3. All cancers combined were significantly elevated in each of the four regions. For cancers showing excesses among telephone workers, the MORs tended to be higher in the Northeastern region than in other regions.

Cancer mortality by various job titles among younger women (ages 25 to 49) is shown in Table 4. Office workers showed significantly elevated risks for cancer of the colon (MOR = 2.8; 95% CI = 1.5 to 5.5), rectum (MOR = 4.1; 95% CI = 1.1 to 16.1), lung (MOR = 2.2; 95% CI = 1.2 to 3.8), connective tissue (MOR = 4.9; 95% CI = 1.8 to 13.0), breast (MOR = 2.5; 95% CI = 1.8 to 3.5), and corpus uteri (MOR = 5.1; 95% CI = 1.9 to 13.8). Among telephone operators no significant excesses were observed, but for sites with three or more deaths, elevated MORs were observed for cancers of the colon, lung, cervix, and ovary. Among engineers and technicians, significantly elevated MORs were observed for cancers of

TABLE 1
Mortality by Selected Cancer Sites and Age Groups Among White Women Employed in the Telephone Industry

Cancer Site	Mortality Odds Ratios, by Age at Death											
	20–49 y			50–69 y			70+ y			All Ages		
	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval
All cancers	206	1.5	1.2–1.8	945	1.3	1.2–1.4	1,192	1.1	1.0–1.2	2,343	1.2	1.1–1.3
Buccal cavity	2	2.0	0.5–8.1	15	1.6	1.0–2.7	14	1.1	0.7–1.8	31	1.3	0.9–1.9
Esophagus	1	3.6	0.5–25.4	6	1.0	0.5–2.2	14	1.4	0.8–2.3	21	1.3	0.8–1.9
Stomach	1	0.5	0.1–3.8	12	1.0	0.6–1.8	26	0.9	0.6–1.3	39	0.9	0.7–1.2
Colon	11	1.4	0.8–2.6	81	1.3	1.0–1.6	194	1.2	1.1–1.4	286	1.2	1.1–1.4
Rectum	4	3.3	1.2–8.7	8	0.9	0.5–1.8	34	1.6	1.2–2.3	46	1.5	1.1–2.0
Liver	1	1.6	0.2–11.1	2	0.7	0.2–2.9	6	1.4	0.6–3.1	9	1.2	0.6–2.3
Pancreas	4	1.6	0.6–4.2	44	1.4	1.0–1.8	71	1.0	0.8–1.3	119	1.1	1.0–1.4
Lung	24	1.3	0.8–2.0	202	1.1	0.9–1.2	193	1.2	1.0–1.4	419	1.1	1.0–1.3
Connective tissue	8	4.4	2.2–8.8	4	0.9	0.3–2.3	9	1.5	0.8–2.7	21	1.7	1.1–2.6
Melanoma	4	0.8	0.3–2.2	14	1.7	1.0–2.9	11	1.2	0.7–2.1	29	1.3	0.9–1.9
Breast	75	1.6	1.3–2.1	242	1.5	1.3–1.8	179	1.1	1.0–1.3	496	1.4	1.3–1.5
Cervix	8	0.9	0.4–1.8	6	0.4	0.2–1.0	18	1.5	0.9–2.3	32	0.9	0.6–1.3
Corpus uteri	6	3.3	1.5–7.5	23	1.3	0.8–1.9	39	1.3	0.9–1.7	68	1.3	1.1–1.7
Ovary	17	2.1	1.3–3.5	71	1.5	1.2–1.9	60	1.1	0.9–1.5	148	1.4	1.1–1.6
Bladder	0			11	1.9	1.1–3.5	22	0.9	0.6–1.4	35	1.0	0.7–1.4
Kidney	0			15	1.2	0.7–2.1	19	1.0	0.6–1.5	34	1.0	0.7–1.4
Brain	13	2.1	1.2–3.7	20	1.0	0.6–1.6	21	1.2	0.8–1.9	54	1.2	1.0–1.6
Non-Hodgkin's lymphoma	5	1.1	0.5–2.7	40	1.7	1.2–2.3	46	1.0	0.7–1.3	91	1.2	1.0–1.5
Multiple myeloma	1	1.3	0.2–9.0	18	1.6	1.1–2.6	22	1.0	0.6–1.5	41	1.2	0.9–1.6
Leukemia	5	0.8	0.3–1.9	20	1.1	0.7–1.7	43	1.0	0.7–1.3	68	1.0	0.8–1.2

TABLE 2
Mortality by Selected Cancer Sites and Age Groups Among Black Women Employed in the Telephone Industry

Cancer Site	Mortality Odds Ratios, by Age at Death											
	20–49 y			50–69 y			70+ y			All Ages		
	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval
All cancers	47	1.6	1.1–2.2	41	1.6	1.1–2.4	13	1.2	0.6–2.1	101	1.5	1.2–1.9
Buccal cavity	1	2.2	0.4–12.3	2	4.0	0.6–28.5	0			3	2.8	1.0–8.2
Esophagus	1	2.8	0.4–19.6	0			0			1	0.7	0.1–5.1
Stomach	0			1	1.6	0.2–11.1	0			1	0.5	0.1–3.5
Colon	5	2.9	1.2–6.9	4	1.7	0.6–4.6	1	0.6	0.1–4.0	10	1.7	0.9–3.2
Rectum	0			1	3.5	0.5–23.9	0			2	3.0	0.8–11.8
Liver	1	6.7	0.9–47.7	0			0			1	2.9	0.4–20.1
Pancreas	0			3	2.2	0.7–6.7	1	1.1	0.2–7.2	4	1.4	0.5–3.7
Lung	6	2.3	1.0–5.2	7	1.3	0.6–2.9	2	1.3	0.3–5.3	15	1.6	0.9–2.7
Connective tisssue	0			0			0			0		
Melanoma	2	27.9	6.9–112.1	0			1	23.7	3.3–170.6	3	16.6	5.4–51.1
Breast	23	2.1	1.3–3.2	13	2.5	1.4–4.5	3	2.0	0.6–1.3	39	2.2	1.6–3.1
Cervix	4	1.3	0.5–3.3	1	0.8	0.1–5.3	1	2.9	0.4–20.5	6	1.2	0.6–2.8
Corpus uteri	0			1	1.2	0.2–8.6	0			1	0.5	0.1–3.7
Ovary	1	1.1	0.2–7.6	3	2.8	1.0–8.1	1	2.3	0.3–16.1	5	2.1	0.9–4.8
Bladder	0			0			0			0		
Kidney	0			0			0			0		
Brain	1	1.7	0.2–11.6	0			0			1	1.0	0.2–6.9
Non-Hodgkin's lymphoma	1	1.4	0.2–9.4	1	2.4	0.4–17.6	1	5.0	0.7–33.9	3	2.3	0.8–6.8
Multiple myeloma	0			0			0			0		
Leukemia	0			1	2.1	0.3–14.2	1	3.5	0.4–22.4	2	1.0	0.3–3.8

TABLE 3
Mortality for Selected Cancers Among Women (Black and White Combined) Employed in the Telephone Industry, by Geographic Region

Cancer Site	Mortality Odds Ratios, by Geographic Region											
	West			Central			South			Northeast		
	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval
All cancers	298	1.2	1.1–1.4	1,117	1.2	1.1–1.2	554	1.2	1.1–1.3	475	1.4	1.2–1.5
Buccal cavity	4	1.4	0.5–3.7	17	1.5	0.9–2.4	7	1.3	0.6–2.6	6	1.4	0.7–3.1
Esophagus	6	2.9	1.3–6.5	8	0.9	0.5–1.8	2	0.5	0.1–2.0	6	1.9	0.9–4.0
Stomach	7	1.4	0.7–2.8	17	0.8	0.5–1.2	7	0.7	0.3–1.5	9	1.1	0.6–2.2
Colon	32	1.2	0.8–1.6	141	1.2	1.0–1.4	60	1.2	0.9–1.5	63	1.5	1.2–1.9
Rectum	8	2.2	1.1–4.3	19	0.8	0.5–1.2	8	1.2	0.6–2.4	13	2.3	1.4–4.0
Liver	2	2.0	0.5–8.1	4	1.1	0.4–2.8	2	1.1	0.3–4.1	2	1.5	0.4–5.8
Pancreas	12	1.0	0.6–1.7	59	1.1	0.9–1.5	28	1.2	0.8–1.8	24	1.3	0.9–1.9
Lung	60	1.3	1.0–1.7	193	1.1	0.9–1.3	91	1.0	0.3–1.3	90	1.4	1.1–1.7
Connective tissue	5	3.0	1.3–6.9	7	1.1	0.5–2.4	3	0.9	0.3–2.8	6	2.7	1.3–5.8
Melanoma	5	1.6	0.7–3.8	9	0.9	0.5–1.7	14	2.5	1.5–4.2	4	1.1	0.4–3.0
Breast	58	1.2	0.9–1.6	224	1.3	1.1–1.5	141	1.5	1.3–1.8	112	1.8	1.5–2.2
Cervix	6	1.1	0.5–2.5	14	0.8	0.5–1.3	9	0.8	0.4–1.5	9	1.4	0.8–2.7
Corpus uteri	5	0.8	0.3–1.9	39	1.5	1.1–2.1	10	0.9	0.5–1.6	15	1.6	1.0–2.7
Ovary	18	1.3	0.8–2.1	70	1.3	1.1–1.7	38	1.5	1.1–2.0	27	1.4	1.0–2.0
Bladder	5	1.5	0.6–3.4	15	1.0	0.6–1.6	4	0.6	0.2–1.7	9	1.6	0.9–3.2
Kidney	7	1.7	0.8–3.5	18	1.1	0.7–1.7	6	0.8	0.3–1.7	3	0.5	0.2–1.5
Brain	7	1.2	0.6–2.5	28	1.4	1.0–2.0	14	1.3	0.8–2.1	6	0.8	0.4–1.7
Non-Hodgkin's lymphoma	22	0.9	0.6–1.4	49	1.3	1.0–1.7	22	1.3	0.9–2.0	13	1.0	0.6–1.7
Multiple myeloma	4	1.0	0.4–2.5	18	1.0	0.6–1.6	13	1.6	1.0–2.8	6	0.9	0.4–2.1
Leukemia	8	0.9	0.5–1.8	36	1.0	0.7–1.4	17	1.1	0.7–1.7	9	0.7	0.4–1.4

the connective tissue (MOR = 8.5; 95% CI = 1.51 to 47.3), breast (MOR = 2.7; 95% CI = 1.3 to 6.0), and ovary (MOR = 6.6; 95% CI = 3.0 to 14.4). Mechanics and repairers had nonsignificant excesses of breast cancer.

Discussion

Among women employed in the telephone industry, significantly elevated mortality among white women was observed for cancers of all sites combined and for colon, rectum, connective tissue, breast, corpus uteri, ovary, and brain; among black women, excesses were seen for cancers of all sites combined and for buccal cavity, melanoma, and breast.

TABLE 4
Mortality for Selected Cancers Among Black and White Women (Ages 25 to 49) Employed in the Telephone Industry, by Job Title

Cancer Site	Mortality Odds Ratios, by Occupation in the Telephone Industry											
	Office Workers			Telephone Operators			Engineers and Technicians			Mechanics and Repairers		
	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval	Number	Mortality Odds Ratios	95% Confidence Interval
All cancers	117	2.0	1.6–2.7	45	1.0	0.7–1.5	19	2.1	1.1–3.9	21	1.3	0.7–2.2
Buccal cavity	1	2.0	0.3–13.8	0			0			0		
Esophagus	1	4.5	0.7–29.5	1	5.1	0.8–33.5	0			0		
Stomach	0			0			0			1	3.7	0.5–25.0
Colon	9	2.8	1.5–5.5	3	1.2	0.4–3.7	0			1	1.1	0.2–7.5
Rectum	2	4.1	1.1–16.1	1	2.7	0.4–18.3	0			0		
Liver	1	3.6	0.6–22.5	1	5.0	0.8–31.7	0			0		
Pancreas	2	2.0	0.5–8.0	0			1	6.5	1.0–40.2	0		
Lung	15	2.2	1.2–3.8	7	1.2	0.5–2.5	0			2	0.9	0.2–3.6
Connective tissue	4	4.9	1.8–13.0	1	1.7	0.3–11.2	1	8.5	1.5–47.3	1	4.4	0.7–27.9
Melanoma	3	1.7	0.5–5.2	61	0.9	0.2–5.5	0			0		
Breast	49	2.5	1.8–3.5	14	0.9	0.5–1.6	9	2.7	1.3–6.0	9	1.6	0.8–3.2
Cervix	4	0.9	0.4–2.4	5	1.5	0.6–3.7	0			1	0.8	0.1–4.9
Corpus uteri	4	5.1	1.9–13.8	2	3.2	0.9–11.8	0			0		
Ovary	6	2.1	0.9–4.6	3	1.3	0.4–3.9	3	6.6	3.0–14.4	1	1.1	0.2–7.2
Bladder	0			0			0			0		
Kidney	0			0			0			0		
Brain	5	2.1	0.9–5.0	2	1.3	0.3–5.0	0			2	3.0	0.8–11.3
Non-Hodgkin's lymphoma	2	1.1	0.3–4.2	0			1	3.7	0.5–26.3	1	2.0	0.3–12.4
Multiple myeloma	1	2.8	0.4–19.0	0			0			0		
Leukemia	3	1.1	0.4–3.5	1	0.6	0.1–3.7	0			0		

Although various occupation-related investigations have been carried out among employees in the telephone industry,[2–13] few have focused on cancers.[14–16] In 1981, Wiklund et al[15] conducted a retrospective study of leukemia among telephone operators in Sweden and found no excess. Matanoski et al[16] conducted a study among male telephone linemen in the cohort study of telephone workers and found a significant excess of leukemia and a nonsignificant excess risk of male breast cancer.[17] Workers with cumulative exposure to electromagnetic fields above the median for the population had leukemia rates 2.5-fold higher than workers below the median.[16] Tornqvist et al[18] conducted a 19-year follow-up study among "electrical occupations," including engineers, technicians, linemen, and repairmen in the telephone industry in Sweden. Standardized mortality ratios from leukemia were 2.1, 1.5, and 1.4 for engineers and technicians, linemen, and repairmen in the telephone industry, respectively, but no excess from brain cancer was observed. We observed no excess of leukemia in any age, race, occupational, or regional group, but we did see an elevated risk (MOR = 2.1; 95% CI = 1.2 to 3.7) of brain cancer among younger women (age <50 years).

In addition to these specific studies in the telephone industry, several broad occupational mortality surveys of both women and men[19–21] and of men only[22–23] have evaluated the telephone industry. Excess cancer of the skin was observed among Danish women in the communication industry, whereas risk of melanoma of the skin was significantly elevated among men.[19] In Milham's Washington state mortality survey,[21] elevated risks were observed for cancer of the cervix among female telephone operators.

In a study of US veterans, melanoma of the skin was significantly elevated among male telegraph, telephone, and power line and service workers.[22] Elevated risks of cancers of the colon (proportional mortality ratio [PMR] = 132), pancreas (PMR = 129), melanoma (PMR = 244), kidney (PMR = 150), brain (PMR = 117), and Hodgkin's disease (PMR = 156) among younger (age <65 years) line workers and telephone service workers in British Columbia have been reported by Gallagher et al.[23] Our study also observed elevated risks of cancers of the colon, pancreas, and brain among younger women (age <50 years) in the telephone industry.

Although this is the largest cancer mortality data set reported for the telephone industry, results should be interpreted cautiously because of the limitations of the data. First, because of the number, some excesses simply may be chance occurrences. Second, data are based on death certificates, without information on the population at risk. Because we did not have information on population at risk, we were limited to use the MOR, PMR, or proportionate cancer mortality ratio to approximate the cause-specific standardized mortality ratios. Several investigators have commented on the limitations and advantages of these measures.[3,27–33] We decided to use the MOR because of its ability to reduce the arbitrary element of the PMR, which is dependent on the size of the auxiliary-causes domain.[33]

Third, misclassification of disease and exposure may arise from the use of death certificates. Several studies evaluated the quality of cause-of-

death information by comparing the specified underlying cause of death to autopsy reports or hospital records.[34–41] The accuracy of cancer death certificates varies by cancer site. For example, among 10 leading cancer sites, cancers of the lung, breast, prostate, pancreas, bladder, and ovary and leukemia have high accuracy rates, whereas colon cancer is overreported, and rectal cancer is underreported on death certificates.[34] The quality of information on occupation and industry also has been evaluated by several investigators, using employment information from interviews or other sources.[42–47] Although percent agreement varied from study to study and occupation to occupation, Houck and Milham[47] concluded that, in general, death certificate occupational information is useful, especially for those who had worked more than 10 years in a particular job. However, misclassification of disease and occupation would tend to be nondifferential and most likely to obscure associations.

Finally, lack of information on confounding factors such as lifestyle—including smoking, alcohol, diet, socioeconomic status, or other occupational and environmental exposures related to disease outcomes—could affect results obtained in this study. Confounding factors could diminish true associations or create spurious ones. However, we believe that, for screening purposes, this omission may not be so crucial, because even for lung cancer, smoking seldom confounds occupational associations.[48–50] Despite these limitations, death certificate data are useful for screening work-related conditions and generating hypotheses in occupational epidemiology. The ready availability of a large number of events is the major advantage of these data.

In summary, we evaluated mortality among women in the telephone industry. Among younger (age <50 years) white women, significant excess risks were observed from cancers of the rectum, connective tissue, breast, corpus uteri, ovary, and brain. We did not have information on other risk factors for these cancer sites; therefore, socioeconomic status or lifestyle factors may explain these observations, particularly for reproductive cancers. Among young women (ages 25 to 49), the observed excesses are more evident, particularly for engineers and technicians and office workers. Possible exposure to technological advancement in the modern telephone industry may account for excess risks observed in this study, particularly among younger women.

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